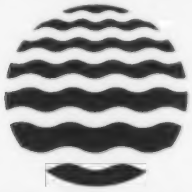
STOPPING WATER POLLUTION AT ITS SOURCE



MISA

Municipal/Industrial Strategy for Abatement

ECONOMIC IMPLICATIONS OF THE MISA MONITORING REGULATIONS ON ONTARIO'S MINERAL INDUSTRY: GROUP "A"

Ontario

Ministry of the Environment

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Minister

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MUNICIPAL-INDUSTRIAL STRATEGY FOR ABATEMENT
(MISA)

DRAFT

ECONOMIC IMPLICATIONS OF THE MISA MONITORING REGULATIONS ON ONTARIO M RAL INDUSTRY: GROUP "A"

Socio-Economic Section
Policy and Planning Branch

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ABSTRACT

Estimates of the incremental capital and operating costs to Ontario's 86 mines who are direct dischargers subject to MISA monitoring requirements are derived and summarized. Cost estimates include costs provided by the Ontario Mining Association.

Five key monitoring activities are identified:

- sampling requirements
- analytical requirements (characterization and routine analyses)
- toxicity testing
- flow measurement
- reporting

Because of uncertainties as to how mines would fulfill the sampling requirements two scenarios have been developed. One scenario involves sampling undertaken by mine personnel and the other by consultants.

Incremental capital costs for the sector are estimated to range from $4.6 to $9.2 million. The range in costs is due primarily to differences in capital cost estimates for flow measurement.

Operating costs over the 12 month period range from $14.2 to $23.2 million. The upper estimate reflects the costs associated with contracting a consultant for sampling, while the lower estimate is based on mine personnel.

The total estimated incremental cost of the MISA monitoring requirements for the Group "A" mines ranges from $19.0 to $32.0 million.

The average cost per mining operation ranges from approximately $220,000 to $380,000.

Unlike the petroleum refining sector, the iron and steel sector monitoring requirements involve plant and process-specific requirements. If the iron and steel sector plants were subject to a single, equitable monitoring requirement, as in the petroleum sector, routine monitoring costs would be approximately $7.6 million compared with $4.4 million under the proposed regulation. This difference of $3.2 million represents a cost saving, and is a measure of the cost-effectiveness of the subsector and stream specific approach proposed for the Group "A" sector.

ABSTRACT (Continued)

The financial impacts of the estimated monitoring costs on the Group "A" sector were analyzed using historical financial data for the period 1981-1987.

The two salt mining companies have been consistently profitable over the past 5-6 years and the estimated incremental monitoring costs do not appear to be a potential burden to these firms.

The monitoring cost estimates decreased the return on capital employed ratio marginally for the majority of the 21 firms. Capital costs for monitoring would account for between 1.5% and 0.3% of total capital investment for these 21 companies.

Four companies had losses in 1987 and in previous years. However, these companies are in the process of bringing mines into production in the upcoming year. The favourable liquidity position of these expected companies together with earnings from gold operations in 1989 suggest that these companies will have the sufficient funds to meet additional environmental expenditures due to monitoring.

Potential benefits to the firms of the monitoring regulation include gains in productivity by improving processes, reduction in raw material losses in wastewater, and goodwill gained by demonstrating to the public that they are responding to environmental problems.

The monitoring regulations may have a positive impact on employment in the Group "A" sector and will stimulate demand for laboratory services and flow measurement and sampling equipment. The monitoring database will be available to design cost-effective control programs aimed at eliminating toxic contamination where it occurs.

1.0 BACKGROUND AND PURPOSE OF REPORT

1.1 MISA Objectives

The MOE's Municipal-Industrial Strategy for Abatement (MISA) is intended to achieve the "virtual elimination of toxic contaminants in municipal and industrial discharges into waterways."

The MISA program consists of three broad components:

1. Development and promulgation of Regulations which specify (a) contaminant monitoring requirements, and (b) effluent limits.

2. Development of these effluent limits based on "best available technology economically achievable" (BATEA) or water quality impacts.

3. Implementation of abatement programs and enforcement activities.

Economic assessments of each component of the MISA program are also being prepared. These assessments are intended to show the costs of the various regulations and other program elements and the economic and financial implications of these costs.

The MISA program will encompass at least 200 Ontario industrial establishments which discharge contaminants directly into waterways disaggregated into nine industrial sectors:

- petroleum refining
- organic chemical manufacturing
- pulp and paper
- iron and steel
- metal mining and refining
- industrial minerals and manufacturing
- electric power generation
- inorganic chemicals
- metal castings.

The first phase of the MISA regulatory program is the promulgation of monitoring regulations for all plants within each of the industrial sectors which discharge waste waters directly into Ontario surface waters.

Other firms and plants in each of the sectors will eventually be subject to monitoring requirements by virtue of a sewer use program being developed by the Ministry.

All direct dischargers are subject to a "General" and "Sector Specific" monitoring regulations. They continue in force during the subsequent 12-month period. It will be terminated, at the end of one year. Further monitoring requirements will then be specified in a subsequent "Effluent Limits Compliance Regulation".

1.2 Definition of the Mining Sector

For purposes of developing MISA regulations, mining operations in Ontario have been divided into two "Groups": A and B. Group "A" includes metal ore producing mines together with salt mines which are direct dischargers. Group "B" consists of non-metallic mines and quarries such as gypsum, cement and other construction materials. This report focuses on Group "A" mines.

Metal mines subject to MISA regulations are further sub-divided into five sub-sectors according to product. The number of mines which are subject to MISA monitoring regulations in each sub-sector, including salt, is shown in Table 1. A detailed list of the mines involved can be found in Appendix 1. The number of mines subject to the regulation could change in the future as mines come into production and as mines become inactive.

TABLE 1.1

The Number of Group "A" Mines Subject to MISA Regulations By Subsector

Subsector	No. of Mines
Copper, lead, zinc and nickel	19
Gold	49
Silver	7
Iron	3
Uranium	9
Salt	2
TOTAL	89

The Group "A" mine properties subject to MISA regulations account for about _____% of the _____ currently recorded mining operations in Ontario. The 89 mines are owned by about 44 companies of record (A.R.A. Consultants, October 1988: Table 1). Mines subject to the MISA monitoring regulations are direct dischargers and discharge over 50,000 litres of effluent per day. If an operation is an exploration site where a mineral product is not being commercially recovered, then an EXP/DEV designation is given in Schedule B of the Regulation. The monitoring required of an EXP/DEV property is similar to that presently specified under existing Certificates of Approval which these properties are already required to obtain. No additional financial outlay is required. There are three properties designated EXP/DEV in the gold sector and two in the silver sector.

Gold mines with production below 1,000 tonnes per day are not required to monitor for certain parameters as frequently as larger companies (exceptions are given at the end of the gold sector section of Schedule A). This concession was made to decrease the financial impact on smaller gold mines.

Additional information about the physical and economic dimensions of the metal mining industry in Canada and Ontario may be found in the report, "Industry Profile: The Metal Mining and Refining Sector", A.R.A. Consultants (1988) and in the references cited in that report. Data used in the assessment of economic impacts of monitoring costs were obtained from the A.R.A. report.

1.3 Purpose and Objectives of Present Report

The monitoring requirements for each industrial sector subject to MISA regulations have been developed during negotiations with industry representatives through a Joint Technical Committee (JTC). Cost-effectiveness has been considered in arriving at the agreed-to protocols and requirements.

This report is intended to present estimates of the potential incremental costs to the direct discharging Group "A" mines in Ontario of implementing the sector specific and general monitoring regulations. The costs of monitoring were estimated for the 84 mines. As mentioned above the 5 EXP/DEV properties will not incur any

additional expenses and therefore were not included in the report. The economic effects and financial implications of these costs on the sector and individual firms will be analyzed where data are available. Implications for the two salt companies subject to this regulation will also be examined.

The current monitoring regulation has gone through several versions, resulting in a regulation that satisfies government objectives, industry concerns and public representative suggestions. Evidence of the cost-effectiveness of the proposed requirements is revealed by comparing the costs associated with the proposed requirements with potential costs incurred under a more comprehensive across-the-board set of requirements.

This scenario may be interpreted as "equitable" in that all mines have to conduct the same number and kind of analytical tests regardless of the metal mined. These estimates show how much monitoring costs have been reduced by developing requirements which are specific to each product subsector and to each effluent type.

1.4 Cost Estimation Methodology

Incremental costs of monitoring consist of recurring operating costs and one time capital and installation costs. In this report, capital and operating costs have been estimated for each monitoring function at each mine site.

Steps involved in cost estimation include the determination of the activities and items that are required to implement each monitoring function and the stated use of simplifying assumptions where necessary.

Cost estimates are based on specifications in the regulations.

With the concurrence of the Ontario Mining Association, the cost of analytical testing was estimated by assuming that all analytical testing conducted by a commercial laboratory. This assumption was made in order to obtain comparable cost estimates for each of the mines. However, few mines have the capability of conducting all of the analytical tests in-house. In cases where mines intend to do some or all of the testing in house, the analyses costs may be overestimated.

Estimates presented in this report provide indications of the magnitude of costs that the sector may incur by complying with the MISA monitoring regulations. Cost estimates for individual mines are uncertain, and should be viewed as bench-marks which may deviate from actual costs. The greatest degree of uncertainty lies in estimates for flow measurement costs. The OMA indicated that because of the large number of mines, it was very difficult to ascertain what equipment exists at the mines and what additional equipment would be required to comply with the regulations. Also, installation of weirs and flumes are very site specific and are therefore difficult to generalize across the mines.

Cost estimates for the two salt mines, Domtar and Canada Salt Company, have been derived using the same assumptions as for metal mines. However, because it is likely that the salt mines may fulfill the monitoring requirements differently than the metal mines, further analyses on the estimated costs of monitoring for the two salt companies will be conducted.

Single-valued or point estimates are presented, but should be treated with caution because inputs required for different types of monitoring functions are often uncertain. Moreover, there is some flexibility as to how individual mines may implement some of the monitoring requirements. For these reasons, ranges of costs are estimated for each monitoring function.

All cost estimates are expressed in 1988 dollars.

1.5 Pre-Regulation Consultation and Meetings

Industry representatives from the Group "A" mining sector spent time at meetings and review committees in order to participate in the development of the regulations.

The OMA reported they spent an estimated 880 hours in meetings with the Group "A" Joint Technical Committee (JTC) and its Analytical and Regulation Subcommittees over a 12-month period. In addition, OMA members devoted about 880 hours to complete monitoring tasks while 352 person-hours were involved in regulation writing meetings. In total, approximately 2,112 person-hours were spent for pre-regulation assessments, consultation and meetings.

Participation in these meetings may represent an opportunity cost in terms of time spent away from regular business. According to industry representatives, personnel involved in these meetings earn $60,000 per year. Valued in terms of these gross salary dollars, the cost of pre-regulation consultation and meetings would be approximately $43,200, not including transportation. Transportation costs for the members to attend meetings in Toronto amounted to $79,500. Additional expenses and consultant fees incurred totalled $256,500. The total cost of pre-regulation monitoring meetings was approximately $329,500. However, because these employees are salaried (i.e., they are paid whether they work on MISA or on other assigned duties), the true opportunity cost may be some amount less than these gross values. This will be particularly true where dealing with environmental regulations is part of the employee's regular duties.

Pre-Regulation activities were a voluntary aspect of the program. The potential incremental costs of monitoring which are estimated in the next chapter are based on activities required by the Regulation. Pre-Regulation costs are not included in the assessment of the economic implications of the monitoring costs presented in Chapter 3.

2.0 MONITORING COST ESTIMATES

2.1 Regulation Requirements

The General Effluent Monitoring Regulation specifies requirements for five major monitoring activities which each wastewater discharger must implement to various degrees and levels of effort.

1. Sampling requirements
2. Analytical requirements (characterization and routine analyses)
3. Toxicity testing
4. Flow measurement
5. Data reporting including preparation of an "Initial Report"

Four types of sampling points or effluent streams are defined in the specific regulation for this sector.

1. Process effluent
2. Mine-Water effluent
3. Smelter/Refinery effluent
4. Stormwater

The process effluent refers to water discharged from an active tailings area at a mining operation. Stormwater effluent refers to water discharged from inactive tailing areas and includes any effluent from parking lots and chemical storage areas.

Monitoring schedules, which specify analytic requirements, for Group A mines differ for each subsector. However, all mines within a subsector are subject to a generic monitoring schedule. This has been done to reflect the different processes employed within each subsector and the different contaminant mix generated by them.

As shown in Table 2.1, most mines have only one sampling point to monitor. Mines generally discharge water from two sources: water pumped from the mine and wastewaters pumped to tailings areas. Therefore, at most mines the sampling point is either minewater effluent or the "process effluent" as defined above.

TABLE 2.1 NUMBER OF SAMPLING POINTS PER SUBSECTOR		
Subsector	# of Mines	# of Sampling Points
Copper, Lead, Zinc, Nickel	19	20
Gold	46	50
Silver	5	5
Iron	3	3
Salt	2	5
Uranium	9	12
TOTAL	84	95

Unlike other industrial sectors continuous flow measurement is not required for this sector. Each mine is required to measure or estimate the flow of each effluent stream at the time of sampling, within an accuracy of $\pm$ 20% of the actual flow.

2.2 Sampling Requirements

Sampling protocols and specifications are defined in Section 3 of the "Effluent Monitoring - General" regulation.

Sampling involves traveling to the designated sampling point, collecting samples, storing samples prior to shipment to laboratories and then transporting them to a commercial laboratory for analyses. Samples must be taken for characterization analyses, routine testing and for toxicity tests.

Because of the uncertainty as to how mines would fulfill the sampling requirements, two scenarios have been developed. One scenario involves sampling undertaken in-house and the other by consultants.

In-house Sampling

In this scenario, sampling will consist of both operating and capital expenditures.

Capital costs for sampling include:

- new vehicle, snowmobile (if purchased);
- modifications to facilities and laboratory equipment;
- supplies; and
- refrigerator.

The OMA assumed that each mine would purchase a van, at a cost of $22,000. Because most of the mines are located in northern Ontario, collecting and taking samples becomes more difficult in winter months. Mine operations could either plow the access road to the sampling point or use a snowmobile during the winter months. A snowmobile would result in an additional expenditure of $3,000.

The regulations further require that samples be stored at a temperature no higher than 10°C. Each mine will require a refrigerator. The OMA estimated that storage refrigerators would cost $3,000 each.

Lastly, modifications to facilities and supplies required would total $3,200 per site.

Estimated capital costs associated with sampling in-house would total $31,200 per site, amounting to $2.7 million for the Group "A" mines.

Operating expenditures consist of the following components:

- operation and maintenance of flumes;
- operation and maintenance of a vehicle;
- personnel.

The OMA estimated $7,500 per year for operation and maintenance of a van.

Assuming the mines purchase a snowmobile, additional operation and maintenance expenses will be incurred. The snowmobile is estimated to travel 600 km a year within the mine operation. This estimate is based on traveling 10 km per day, 3 days a week for five months. Using a government rate of $.275 per km, operation and maintenance of a snowmobile would amount to $165 per year.

Operation and maintenance estimates for both the van and snowmobile totals $7,665 per year.

Based on estimates from the OMA, one person-year per mine would be required to take samples, measure flows and record data. The annual salary for this individual was estimated to be $40,000. Estimates from other industrial sectors suggest that dedication of one person-year may be an overestimate of the staff requirements for these activities.

Operation and maintenance of the weirs and flumes is required to keep these devices clear of ice in the winter and free from the handiwork of beavers. The OMA estimated that 2 to 8 person-days would be required per flume per year. Valuing the time at $20/hr, operation and flume maintenance ranges from $320 to $1,280 per year.

In total, operating costs for sampling in-house range from $48,000 to $49,000 per year per mine. Costs for individual mines will differ depending on the number of effluent streams that will require sampling.

The total incremental operating and capital costs of in-house sampling ranges from $79,200 to $80,000, per mine per year and totals approximately $6.8 million for the Group "A" sector excluding transportation. Table 2.2 summarizes the capital and operating cost estimates by subsector. These estimates do not include transportation of samples to laboratories for analytical testing.

Sampling may be contracted to a consultant if the mine management does not have the necessary trained personnel. The consultant would be responsible for collecting and recording the samples and arranging transportation. Transportation costs for the samples will be incurred regardless of which scenario the mine chooses and so will be calculated separately.

Sampling Undertaken By Consultant

Because there is a limited number of consulting companies in Northern Ontario with the necessary technical expertise, the OMA assumed that the mines would contract consultants from the Toronto region. Personnel would fly to the mine-sites each week in order to fulfill the sampling requirements.

In this scenario, the capital expenditures include a commercial refrigerator to store samples, and the purchase of a van. Using the OMA's estimate of $3,000 for the refrigerator and $22,000 for a new van, capital costs total $25,000 per mine and $2,100,000 for the Group "A" sector.

The OMA estimated that one employee of the consultant would be required 8 hours a day, five days a week for 12 months. At an hourly rate of $45, this amounts to $93,600 for the 12-month period per site. Estimated expenses for accommodations, meals and airport parking for 5 days a week over 12 months are listed below.

Accommodation:	$55 per day
Meals:	$30 per day
Airport Parking:	$10 per day
Airport Mileage:	100 km @ $.25 km
Miscellaneous Expenses:	$10 per day

Vehicle operation and maintenance amounted to $7,500 per year.

Estimates of transportation costs of the consultant were also prepared. Due to the large number of mines in this sector, a typical site was selected from each subsector which represented the median travel distance. The annual air fares for the representative sites are as follows:

Subsector	Return Air Fare	Cost Per Year
Copper, Lead, Zinc	$545	$28,340
Gold	$545	$28,340
Uranium	$320	$16,640
Iron	$386	$20,007
Silver	$352	$18,304
Salt	$275	$14,300

These transportation costs will understate the actual costs for some mines and overstate them for others. Moreover, if consultants obtained fare discounts, actual transportation costs may be somewhat less than these estimates.

Total annual operating costs for sampling by a consultant range from $144,000 to $158,000 per mine-site, and total $13.5 million for the entire Group "A" sector.

The estimated costs for sampling for each scenario are summarized by subsector in Table 2.2.

The total cost of sampling for the Group "A" sector would be approximately $6.8 million if undertaken in-house and $15.7 million if undertaken by a consultant. Sampling by a consultant would cost $8.9 million more than if the activity were carried out internally.

If personnel are available both within the mine and in neighbouring communities, the least-cost option for the mine is to undertake sampling internally.

Sampling will be carried out in-house by some mines and by consultants for others. Therefore, these two sets of estimates provide a range for the actual sampling costs.

TABLE 2.2

RANGE OF TOTAL INCREMENTAL COSTS FOR SAMPLING

($ 000)

Subsector	In-House Sampling	Consultant Sampling
	($'000)	($'000)
Gold	3,643	8,578
Iron	237	524
Silver	553	1,211
Uranium	715	1,568
Salt	163	338
Copper, Lead, Zinc, Nickel	1,503	3,478
TOTAL	6,814	15,698

2.3 Analytical Testing, Characterization

Analytical testing includes routine analyses, characterization, open characterization and fish toxicity testing. In this section estimates of characterization costs are presented.

The priority pollutants assigned for monitoring of effluents in Group "A" were taken from the Ontario Effluent Monitoring Priority Pollutants List (1987) (EMPPL).

The EMPPL includes chemicals detected in Ontario municipal and industrial effluents and Ontario's waterways which pose a hazard to the receiving environment because of their toxicity and persistence. The EMPPL currently includes 179 chemicals.

Table 2.3 lists the analytical test groups and their prices that are to be tested under the Group "A" regulations.

Monitoring will be also carried out for substances that are somewhat specific to Group "A" mines. These include chlorides, cyanates, thiocynates, iron, uranium and weak dissociable cyanides.

Some test groups, such as Groups 4a, 4b include many specific chemicals. However, the laboratory price given is for a complete analysis of the entire group no matter how many compounds in the group actually need testing. Using these prices in cost estimation results in an over-estimation of analytical costs.

Prices of laboratory tests include quality assurance/quality control (QA/QC) samples and the preparation of required reports, but does not include transportation of samples from the mines to laboratories.

The regulation allows for the samples taken thrice weekly and monthly as required by routine sampling to be used towards characterization analyses. The following cost estimates for characterization reflect this provision.

Characterization analyses requirements are specified in Section 7 of the "Effluent Monitoring - Ontario Mineral Industry: Group "A" regulation". Characterization involves infrequent testing of a small number of analytical test groups.

TABLE 2.3

LABORATORY TEST PRICES FOR ANALYTICAL TEST GROUPS

No.	Analytical Test Group	Price ($) Average
1.	Chemical Oxygen Demand	29.78
2.	Cyanide	36.10
3.	Hydrogen Ion (pH)	6.84
4a.	Amonia Nitrogen plus amonium Total Kjeldahl Nitrogen.	
4b.	Nitrate	86.99
5.	Organic Carbon	57.03
6.	Total Phosphorus	25.12
7.	Conductivity	9.44
8.	Total Suspended Solids (SS) Volatils Suspended Solids (VSS)	14.87
9.	Metals (13 metals)	84.10
10.	Hydrides (Arsenic only)	23.33
11.	Chromium (Hexavalent)	20.47
12.	Mercury	25.77
13.	Total Alkyl Lead	172.00
14.	Phenolics (4AAP)	42.93
15.	Sulphide	30.00
16.	Volatiles, Halogenated	239.90
17.	Volatiles, Non-Halogenated	176.81
18.	Volatiles, Water Soluble	126.50

TABLE 2.3 (Continued)

LABORATORY TEST PRICES FOR ANALYTICAL TEST GROUPS

No.	Analytical Test Group	Price ($) Average
19.	Extractables, Base Neutral	427.49
20.	Extractables, Acid (Phenolics)	245.68
21.	Extractables, Phenoxy Acid Herbicides	188.09
22.	Extractables, Organochlorine Pesticides	270.14
23.	Extractables, Neutral Chlorinated	232.04
24.	PCDDs & PCDFs	1,228.27
25.	Oil & Grease	36.00
26.	Fatty Acids & Resins	133.18
27.	PCBs (Total)	103.90
28a/b	Open Characterization, Volatile and Extractables	500.00
29.	Open Characterization, Elemental	300.00

Source: Inventory and Critical Review of Laboratory Resources, Toronto. Laboratory Services Branch, Ontario Ministry of the Environment, 1988.

Each effluent stream will be characterized quarterly for the analytical test groups specified in the regulation. This includes testing of PCB's and analysis of dioxins. All effluents will be characterized for dioxins once during the 12 month period, and PCBs quarterly for mines where PCB's are stored. If analysis of dioxins was undertaken in pre-regulation analyses it need not be repeated.

The salt subsector will characterize minewater effluents twice a year, because of the very small effluent volumes involved and the routine nature of the effluent (saturated brine).

Open characterization is also required in conjunction with characterization analyses. Open characterizaton will provide identification of organic compounds and elements and will be used to provide identification of compounds which could potentially be added to the EMPPL.

Total annual characterization costs amount to $1.5 million per year for the Group "A" sector. Table 2.4 presents a summary of characterization analyses costs per subsector, which are entirely operating costs.

These estimates do not include Pre-Regulation characterization analyses. Pre-Regulation monitoring is not required by the Regulations, but was an important aspect of the regulation development process.

2.4 Routine Analyses

Routine analyses in this sector involve testing of samples which are taken at two frequency levels - three times per week, and monthly, plus on an event basis for certain sampling points such as stormwater effluent.

Parameters assigned for routine testing are those that historically have been subject to control either at provincial or federal levels.

The cost of routine analyses vary substantially from one subsector to another due to differing testing requirements. However, the costs incurred by individual mines within a subsector differ slightly. This occurs because most mines only sample one effluent stream.

In the gold sector, mines with production below 1,000 tonnes per day are required to monitor for copper, lead, nickel, zinc and arsenic monthly instead of thrice weekly as required for larger companies.

The cost for these tests is approximately $1,300 when tested monthly, compared with $16,700 when tested thrice weekly. However, due to unavailable production data, the following cost estimates do not take into consideration this provision. All mine have been treated identically and the estimates reflect testing the above noted chemicals thrice weekly.

The annual operating cost of routine analyses ranges between $15,800 and $53,400 per mine. The total point estimate for all 84 mines amounts to $4.2 million per year. Again, routine analyses involve no capital costs.

Details of the estimated routine analyses cost for each subsector, excluding transportation, are shown in Table 2.4, below.

TABLE 2.4

OPERATING COSTS OF CHARACTERIZATION AND ROUTINE ANALYSES ($'000)

SUBSECTOR	# OF SAMPLING POINTS	CHARACTERIZATION	ROUTINE
Gold*	57	789	2,713*
Iron	3	41	95
Silver	7	126	79
Uranium	12	162	282
Salt	5	41	86
Copper, Lead, Zinc, Nickel	20	301	896
TOTAL	104	1,460	4,152

* Because of limited data on production, the cost estimate for routine analyses does not include the provision for gold mines producing 1,000 tonnes of ore and less per day. Therefore the figure presented is an overestimate of the total routine costs for the gold subsector.

2.5 Toxicity Testing

Toxicity testing consists of the static 96-hour rainbow trout toxicity test and a 48-hour Daphnia magna (a small invertebrate crustacean) mortality (acute lethality toxicity) test.

Each effluent stream will be tested quarterly.

Toxicity testing costs are based on the following commercial prices:

Trout: $360 per test
Daphnia: $240 per test
$600 per test

These prices do not include costs of collecting the samples or transport to the laboratory.

Using these prices, the total cost of this function during the 12-month period amounts to $235,200 for the Group "A" mines as shown in Table 2.5 below.

TABLE 2.5

ANNUAL OPERATING COSTS - TOXICITY TESTING ($)

SUBSECTOR	# OF SAMPLING POINTS	TROUT	DAPHNIA	TOTAL
Gold	50	73,440	48,960	122,400
Iron	3	4,320	2,880	7,200
Silver	5	7,200	4,800	12,000
Uranium	12	17,280	11,520	28,800
Salt	5	7,200	4,800	12,000
Copper, Lead, Zinc, Nickel	20	28,800	19,200	48,000
TOTAL	95	138,240	92,160	230,400

2.6 Transportation of Samples

Estimated transportation costs provided by the OMA were based on the median distance from a representative property in each subsector to Toronto.

Numbers of samples which would require "same day" shipment because of short holding times were calculated. Samples with longer allowable holding times were considered to be "bulked" into weekly, bi-weekly, monthly and quarterly shipments in order to minimize shipping costs. Estimated tariffs for an overnight courier, as well as for a "two day" refrigerated freight service from each representative site to Toronto were obtained. These estimated costs were then applied to all properties within the given subsector to obtain an estimated total. Based on these assumptions, it is estimated that the costs for sample transportation may be approximately $361,000 for the Group "A" sector. Estimated transportation costs per year per subsector are presented below.

Subsector	Cost Per Year
Base Metals	$ 82,000
Gold	209,346
Iron	13,000
Salt	8,900
Silver	17,000
Uranium	31,000
	$361,161

2.7 Flow Measurement

Each mine is required to measure or estimate the flow of each effluent stream at the time of sampling, within an accuracy of $\pm$ 20%.

Continuous flow measurement is not required due to the long retention time and constant flow rates of the effluent and the mechanical difficulties of monitoring remote points year-round.

Less than 10 percent of Group "A" mines have any type of flow measuring devices, such as weirs, installed at their effluent sampling points.

For those mines that do not have existing equipment, the OMA assumed that a "parshall flume" would be installed in a ditch at each effluent

stream. Sizes and costs associated with installation of flumes will depend on flow volume.

Because flow data were not available for most mines, cost estimates were based on an assumed direct relationship between ore production and flow volume. The more tonnage produced, the greater the flow and hence the need for larger flumes. Escavation, concrete and access road construction costs were estimated by the OMA to range from $19,000 to $70,000 per installation.

For stormwater and minewater effluents, regardless of the amount of ore produced, a standard sized parshall flume was assumed. The OMA estimated $20,000 for installation of this type of flume.

For mines that have existing flumes or weirs, capital costs include calibration of the existing equipment. Calibration costs tend to be site-specific and are, therefore, very uncertain. Because of these uncertainties the OMA suggested a range of between $5,000 and $15,000 per flume for calibration.

Total capital costs for flow measurement range from $1.6 to $5.6 million for Group "A" sector.

Estimated operating costs are based on 2 to 8 person-days per year for flume operation and maintenance. At $20 per hour, this amounts to a range of $.029 to .124 million for the Group "A" mines.

Total incremental capital and operating costs for flow measurement range between $1.6 and $5.8 million for the Group "A" sector.

Table 2.6 and Table 2.7 summarize both capital and operating costs for flow measurement by subsector.

TABLE 2.6

ANNUAL OPERATING COSTS
FLOW MEASUREMENT
($'000)

Subsector	Annual Cost	
	Low	High
Gold	15.3	66.3
Iron	.9	3.9
Silver	1.5	6.5
Uranium	3.6	15.6
Salt	1.5	6.5
Copper, Lead, Zinc, Nickel	5.7	24.7
TOTAL	28.5	123.5

TABLE 2.7

CAPITAL COSTS
FLOW MEASUREMENT
($'000)

Subsector	Annual Cost	
	Low	High
Gold	965	3,320
Iron	44	155
Silver	91	350
Uranium	193	675
Copper, Lead, Zinc, Nickel	67	350
Salt	230	780
TOTAL	1,590	5,630

2.8 Reporting

Reporting consists of two major tasks: development of an "initial report" to the Ministry which details production and wastewater flow diagrams, sampling and testing procedures and analytical facilities to be used and the assembly, entry, storage and reporting of monitoring data to company management and to the Ministry.

Based on the drafting and reporting preparation functions required by the General Regulation the OMA estimated that the initial report would cost $10,800 per effluent stream. Additional effluent streams would result in a cost of $2,700 per stream.

The following is a breakdown of the components of these costs:

Drafting:	60 person-hours @ 30/hr
Report Preparation:	160 person-hours @ 50/hr
Clerical:	30 person-hours @ 25/hr

The initial report may cost approximately $960,000 for the Group "A" sector. These costs have been considered operating expenditures.

Data storage and manipulation will require an AT personal computer together with compatible peripherals and software, plus personnel dedicated to perform report generation functions.

All mines would purchase the computer hardware and software necessary to comply with the regulation. Based on a cost of 10,000 per computer per mine, capital costs of reporting total $840,000 for Group "A" sector.

Because of unavailable technical personnel, the OMA felt that smaller mines, perhaps those producing 400 tonnes per day or less, would hire a consultant to input data. It was estimated that contracting these services may cost approximately $2,000 per month. However, due to incomplete data on tonnage per day, it was not possible to estimate the cost for smaller mines. The estimates presented are based on all mines conducting reporting internally. Therefore, these estimates may overstate the actual costs for the Group "A" sector.

It is assumed that 4 person-hours per day of clerical time would be required to input data. At

a rate of $25 per hour, operating costs would total $36,500 per mine for the 12 month period, totalling $3.1 million for the Group "A" sector.

The total estimated operating and capital cost of the initial report and reporting amounts to approximately $4.0 million for the Group "A" sector for the one year period of the monitoring regulation.

2.9 Monitoring Costs for Salt Producers

Two salt mines are included in the mining Group "A" sector. Preliminary estimates of the potential costs of monitoring at these plants were derived in the previous sections. These estimates were based on assumptions used for the metal mining operations. A further review of the various monitoring costs will be made for the two plants in this sector. Revisions will be made if significant difference are encountered.

One of the mines is located in Windsor and is owned and operated by the Canadian Salt Company (CSC), a wholly-owned subsidiary of Morton Thiokol Inc. An evaporation plant is associated with the CSC salt mine and is also subject to the monitoring regulations. These two establishments have 3 effluents or sampling points between them.

The other salt mine is operated by the Domtar Chemicals Group, and is located near Goderick. The salt mine has two sampling points specified under the regulation.

2.10 Total Estimated Costs of the MISA Mining Group "A" Sector Monitoring Requirements

The total capital costs of compliance are estimated to range from $4.6 million to $9.2 million for the Group "A" sector and are summarized in Table 2.8 by sector. The range in costs is due primarily to differences in capital cost estimates for flow measurement.

Operating costs for the sector over the 12-month period range from $14.2 to $23.2 million. The upper estimate reflects the costs associated with contracting a consultant for sampling, while the lower estimate is based on in-house sampling.

The total incremental costs of the MISA monitoring regulations to the mining sector, Group "A" range

from $19.0 to $32.4 million for the 12-month period.

TABLE 2.8

PRELIMINARY ESTIMATES OF THE INCREMENTAL OPERATING AND CAPITAL COSTS BY SUBSECTOR ($'000)

Subsector	Total Capital		Total Operating	
	Low	High	Low	High
Copper, Nickel, Lead, Zinc	895	1,563	3,149	5,261
Gold	2,575	5,215	8,163	13,435
Silver	316	618	739	1,445
Iron	149	279	443	752
Uranium	508	1,046	1,347	2,267
Salt	137	432	350	543
TOTAL	4,580	9,153	14,193	23,703

Appendix "B" presents the operating and capital monitoring costs per mine.

2.11 Alternative Estimates of Routine Monitoring Costs

The Group "A" Monitoring Regulation specifies different testing requirements for each subsector. If, however, the same parameters were tested at the same frequency in all mines, as in the petroleum refining sector, the cost burdens would differ. This scenario could be viewed as more "equitable", in that all mines would be subject to the same generic testing schedule.

An alternative set of routine analyses costs were estimated for this "equitable" scenario in order to illustrate the cost effectiveness of having requirements specific to each subsector and effluent stream. The following assumptions were used:

- The Group "A" mines subject to the MISA regulations would have to monitor all effluent

streams thrice weekly for the maximum number of contaminants specified in the regulation. Therefore all mines will test for the same chemicals at the same frequency regardless of the mineral mined.

The implications of this scenario for other monitoring functions were not calculated because the requirements and costs for these activities would change only slightly. The largest difference would occur in routine analyses which are estimated below.

This "equitable" scenario would result in routine analyses costs of $77,000 per mine, with a point estimate of $7.6 million for the entire Group "A" sector. This compares to the total estimated routine analyses costs, of the proposed regulation of $4.4 million.

As shown in Table 2.9, the subsector-specific requirements under the proposed regulation is estimated to cost $3.2 million less than the "equitable" scenario. This difference is a measure of the cost-effectiveness of the analytical schedules specified for the Group "A" sector. The MOE has been cognizant of the potential financial implications of the MISA requirements and has incorporated such considerations in the development of the monitoring regulations.

TABLE 2.9

ALTERNATIVE ROUTINE ANALYSES COST ESTIMATE ($'000)

SUBSECTOR	PROPOSED	EQUITABLE	DIFFERENCE	% DIFFERENCE
Gold	2,713	4,086	1,373	51%
Silver	250	385	136	54%
Iron	95	231	136	143%
Uranium	343	925	582	170%
Copper, Lead, Zinc, Nickel	988	1,542	554	56%
Salt	87	385	298	341%
TOTAL	4,476	7,555	3,078	69%

3.0 ECONOMIC EFFECTS AND IMPLICATIONS OF MONITORING COSTS

3.1 Industry Structure and Outlook

Mining is a major contributor to employment and income in Ontario's north. The value of all mineral production in the province was $5.6 billion in 1987 (ARA, 1988). The value of production of the 8 metals of concern to MISA was $3.8 billion or 68% of total mineral production in Ontario in 1987. As Table 1 in Appendix C illustrates, the mining operations under review employed up to 28,000 workers in 1987. (Canadian Mines Handbook, 1988).

The markets for nickel, copper, lead, iron, gold, silver and under review are generally considered competitive internationally with prices being set for the base metals in the London Metal Exchange. Gold and silver are traded on all world markets. The markets for uranium, and zinc are not considered to be perfectly competitive as there are few sellers and, in the case of uranium, even fewer buyers. The uranium market in Ontario is characterized by two sellers, Rio Algom and Denison Mines, and one principal buyer Ontario Hydro. Prices are set in long term contractual agreements (ARA, 1988). The domestic zinc market can be characterized as oligopolistic with Cominco and Noranda setting the price domestically by virtue of their control of output (ARA, 1988).

Iron ore produced in Ontario is seldom traded on open markets. Demand for iron ore is derived from world demand for steel. The producers of iron ore, Dofasco and Algoma Steel Corp., are both integrated steel producers so that iron ore produced is sent directly to their steel operations (ARA, 1988).

Mining is characterized by boom and bust cycles which drastically alter the outlook for producers from year to year. As noted above, the Canadian and Ontario metal industry is heavily dependent upon international markets. During the eighties, domestic producers lost market shares to new sources of production, many of which are located in less developed countries. Some of these producers sell at below cost to obtain foreign exchange, thus contributing to excess capacity for some metals. These factors together with decreased demand resulted in depressed prices for most metals. In response to these conditions, Canadian metal producers underwent significant restructuring, cost cutting and rationalization (ARA, 1988).

Mining operations that produce copper, lead, zinc and nickel face differing outlooks according to the metal produced. The long term outlook of lower prices for copper, lead and nickel will be offset to some degree by the strong zinc prices. Because zinc is an important complement to steel production, zinc prices are expected to remain strong so long as the demand for steel continues to increase.

The price of uranium is expected to remain steady. Although world uranium markets are suffering from excess capacity, long term contracts with Ontario Hydro will shelter Ontario producers from price depression to some extent.

Gold prices are particularly difficult to predict. The price of gold is not only dependent on supply considerations but on political events, the strength of global economics and such macroeconomic issues as inflation. Oversupply has depressed gold prices throughout the 1980's causing a steady decline in prices. Gold markets are experiencing further pressures from new gold mines coming into production in Ontario and elsewhere.

Finally, termination of the "flow-through shares" system scheduled to occur by the end of 1988 may affect the ability of some firms to raise financing in the future.

Procedures for evaluating financial and economic impacts of monitoring costs are presented in the next section.

3.2 Analytical Procedures

In this section, some of the key effects of the incremental monitoring costs on the Group "A" mines as a whole, and on individual firms within the sector, will be examined.

Financial data have been assembled for 21 companies whose shares are publicly traded. These companies operate 60 of the Group "A" mines subject to the MISA Monitoring Regulation. Assessments of the implications of the MISA Monitoring costs have been made only for these companies.

Ideally, the impacts of the incremental costs of monitoring should be analyzed against the projected future values of relevant financial measures. However, because such projections are unavailable,

costs have been assessed against historical data over the period 1983-1987.

Effects on performance measures will be assessed in relation to the average financial performance for each firm over five years. These financial performance measures are examined

- after-tax profits
- capital expenditures
- rate of return on capital employed.

The analysis seeks to determine the extent to which the monitoring costs would reduce the company's performance measures below its own historical averages. Comparisons will also be made with industry performance measures where these are available.

In so far as long term investment decisions are concerned, a key economic variable is the rate of return on investment or "capital employed". This is the return that provides the incentive for owners and investors to remain in a particular business or move on to something else.

Consequently, it is of particular interest to determine how the potentially recurring operating costs associated with environmental protection would have affected the rate of return on capital employed ratio for individual firms and for the industry as a whole.

Return on capital employed is defined as net earnings before income taxes, interest charges and extraordinary items divided by total assets less current liabilities.

In the present analysis, estimated operating costs of monitoring were first reduced by the corporate tax rate 47% (CCH, 1988) subtracted from net earrings to determine a new rate of return on capital employed. This calculation was done for each firm in each year for which data were available. These new rates of return could then be compared with the firms historical performance and with average rates of return for the industry.

A second analysis was carried out to determine the extent to which monitoring capital requirements would direct capital expenditures away from other uses. Estimated capital costs of monitoring were thus computed as a percent of total capital expenditure for each firm each year in which

capital expenditure data are available. There is no rule of thumb as to what proportion of capital should be devoted to environmental protection. However, some industrial representatives assert that a minimum capital expenditure is required each year for repair and replacement just in order to keep a plant running.

This approach to capital expenditures is conservative and overstates the impact because capital costs can normally be depreciated over 3-5 years. Consequently, a proportion of the capital cost would be deducted each year, not the full amount that is used in the present analysis.

International competitiveness of Ontario mining companies may be affected only slightly to the extent that recurring operating costs are increased. Moreover, this issue is of concern only to producers of internationally competitive commodities such as gold, silver, nickel, lead, and copper. Zinc and uranium producers have a greater ability to pass on small cost increases to higher prices by virtue of their market structures.

In sum, these analyses will identify those firms which could experience financial difficulties as the result of monitoring and other future environmental protection costs.

3.3 Financial Implications of the Monitoring Regulation

Prices and demand for metallic minerals are cyclical so that the financial performance of metal mining firms have widely fluctuated with business cycles over the past ten years. Sales and prices were depressed for many firms in the industry during the recession of the early 1980's, so that profits and other performance indicators have only recently begun to recover.

Economic recovery in late 1986 and through 1987 pushed producers of nickel, gold and uranium, such as Inco, Rio Algom, Falconbridge, Placer-Dome, Denison and Noranda, into the top ten mining firms Canada in terms of sales or operating revenues (ARA, 1988).

Data on after-tax profits shown in Table 3.1 reflect this recent recovery. This Table also shows those firms which are currently operating with after-tax losses.

Inco experienced the largest single increase in after-tax profits, rising from $177,000 in 1986 to $125,241,000 in 1987. Belmoral Mines, Giant Yellowknife Mines, LAC Minerals, and Noranda all recorded increases in after-tax profits of over one hundred percent in profits from 1986 to 1987. In 1987, Algoma Steel's after-tax profits increased approximately 130% over 1986. This was the first year that Algoma has made a profit since 1981 (Financial Post Information Service, 1988).

After-tax profit over several years is one indicator of the health of a company and an industry. Table 3.1 shows that most of the mining companies had positive after-tax profits in 1987. The exceptions are Canamax Resources Inc., Muscocho Explorations Limited, Golden Shield Resources and St. Andrew Goldfileds which reported losses of $16, $9, $.3 and $.09 million in 1987 respectively. Both Canamax and Golden Shield Resources have experienced consecutive annual losses since 1983, while Muscocho sustained losses since 1984.

These 4 companies are in the process of bringing properties into production. By 1989, Canamax expects to have 4 gold mines in operation with the ability to produce 100,000 ounces of gold by 1990. St. Andrew Goldfields expects its Stock Township property to also come into production by 1989, (Annual Company Reports, 1987).

Golden Shield Resources recently acquired the Keer Mine and Mill changing the company from a exploration company to a gold producer. They have a base of 40,000 ounces of gold per year. Their annual report suggests an upturn in their profitability in 1988 and a longer term upward trend in profitability, (Annual Company Report, 1987).

Lastly, Muscocho Explorations expects both the Magino and Magnacon properties to come into production in 1988-89. Exploration is being carried out at the Jerome property which will add to their gold reserves. These properties have the proven reserves to produce over 80,000 ounces of gold per year, (Annual Company Report, 1987).

In sum, although these 4 companies posted losses in recent years, returns are expected in the upcoming year as the new mines come into production. Earnings from their gold operations could amount to $102 million in 1989, using the current prices of gold of $465 per ounce (Canadian Dollars).

TABLE 3.1

Annual After- Tax Profits
('000)

FIRM	1983	1984	1985	1986	1987	Average
Aginco Eagle Mines Ltd.	5,531	6,207	6,525	6,625	13,852	7,748
Algoma Steel Corp.	(126,646)	(45,706)	(2,975)	(134,845)	40,251	(53,984)
American Barrick Resources Co	(4,421)	(16,094)	(22,369)	15,062	24,461	(672)
Belmoral Mines Ltd.	(507)	(9,767)	(7,081)	1,378	3,538	(2,488)
Canamax Resources Inc.	(1,051)	(5,448)	(5,148)	(13,893)	(16,127)	(8,333)
Denison Mines Ltd.	101,520	80,516	(157,900)	44,632	27,259	19,205
Dofasco Inc.	120,482	180,605	170,094	135,892	153,990	152,213
Falconbridge Ltd.	(3,542)	80,186	38,543	70,269	73,120	51,715
Giant Yellowknife Mines Ltd.	4,209	1,891	5,690	3,846	12,256	5,578
Golden Shield Resources	(501)	(310)	(116)	(520)	(8,986)	(2,087)
Granges Exploration Ltd.	N/A*	222	592	930	1,463	641
Inco Ltd.	(234,894)	(77,343)	52,212	177	125,241	(26,921)
Lac Minerals Ltd.	27,969	29,307	10,629	(21,203)	38,653	17,071
Minnova Inc.	(39)	891	185	4,652	3,257	1,789
Muscocho Explorations Ltd.	145	(91)	475	(152)	(317)	12
Noranda Inc.	(34,599)	(4,451)	(253,873)	43,346	343,471	18,779
Placer Dome Inc.	29,258	29,363	35,312	93,900	158,200	69,207
Rio Algom Ltd	51,140	73,887	88,348	70,182	93,075	75,326
St. Andrews Goldfields Ltd.	436	477	254	183	(94)	251
Hemlo Gold Mines Inc.	N/A	N/A	N/A	N/A	52,694	52,694
Dickenson Mines Limited	3,610	2,747	1,720	4,590	6,438	3,821
Total	(65,510)	324,342	(40,603)	320,461	1,086,563	325,051

Source: Financial Post Information Service, 1988

Moreover in 1987, the work capital and quick ratios of these companies were above the industry average. The quick ratio was 5.96 for Muscocho, 9.14 for St. Andrew Goldfields, 2.39 for Golden Shield and 3.47 for Canamax compared with 1.47 for the industry. The working capital ratio exhibited similar results.

The favourable liquidity position together with earnings from gold operations in 1989 suggest that these companies will have sufficient funds to meet additional environmental expenditures due to monitoring.

Return on capital employed is another measure of a company's profitability. Table 3.2 and 3.3 shows that the operating costs of monitoring would decrease the return on capital employed only slightly for the majority of the 21 firms evaluated.

These small changes would therefore have little effect on the long term profitability of the firms and would not likely cause these mines to close.

However, for Muscocho Explorations Ltd. operating costs for monitoring causes the ratic to change form a small positive return to a loss of 2.5 to 10% on capital employed for the period 1983-1987. This result reflects weak after-tax profits recorded by this company for these years. Nevertheless, it appears that the company has sufficient working capital to cover the extra monitoring costs. Similarly the rates of return for St. Andrew Goldfield are pushed into a slight loss condition for some years.

Capital expenditure data shown in Table 3.5 reveals that in the aggregate capital expenditures for the 22 companies have increased from a low of $386 million in 1983 to a high of $2 billion in 1987, averaging $1.3 billion over the period 1983-1987. This represents an increase of over 500% and reflects the recent improvement in the metal markets as companies begin to reinvest in expansion projects put on hold during the recession. This expenditure also reflects the major expansion in gold mining that has occurred in this decade.

Capital expenditures for the individual companies vary widely. Capital expenditures for 8 of the 21 companies increased from 1983 to 1987. For the remaining companies no clear trend can be drawn.

TABLE 3.2

RETURN ON CAPITAL EMPLOYED

COMPANY NAME	1983	1984	1985	1986	1987
AGNICO EAGLE MINES	9.73	10.25	9.58	7.10	11.95
ALGOMA STEEL	-4.27	1.51	2.91	-0.07	6.16
AMERICAN BARRICK RESOURCES	-9.75	1.10	4.23	6.89	4.90
BELMORAL MINES	-33.81	11.60	-11.91	3.50	3.38
CANAMAX RESOURCES	-2.30	-11.25	-9.56	-25.79	-24.56
DENISON MINES	8.53	6.81	-9.05	1.47	5.31
DOFASCO	9.12	11.50	8.93	7.33	7.12
ELDORADO NUCLEAR	4.29	5.02	1.89	1.33	9.88
FALCONBRIDGE	3.53	8.09	6.42	4.45	5.81
GIANT YELLOWKNIFE	16.17	6.77	17.37	10.78	8.89
GOLDEN SHIELD	-137.26	-310.00	-6.04	-3.88	-13.14
GRANGES EXPLORATION	N/A	4.49	3.76	1.43	1.29
INCO	-4.53	1.70	5.95	3.76	9.16
LAC MINERALS	13.72	10.48	1.90	4.87	7.06
MINNOVA	-0.03	0.72	0.14	3.20	1.87
MUSCOCHO EXPLORATIONS	5.00	0.27	3.12	-0.71	-0.66
NORANDA	3.21	4.36	3.43	4.35	6.52
PLACER DOME	6.62	4.06	5.47	6.31	8.71
RIO ALGOM	4.69	7.04	7.05	6.67	7.58
ST. ANDREW GOLDFIELDS	1.22	1.23	0.60	0.42	-0.16
METAL MINING INDUSTRY	3.84	5.98	4.80	4.35	7.13

TABLE 3.3

IMPACT OF MONITORING OPERATING COSTS ON RETURN ON CAPITAL EMPLOYED
MINE SAMPLING

COMPANY NAME	1983	1984	1985	1986	1987	Average
AGNICO EAGLE MINES	8.91	9.47	8.90	6.46	11.37	9.02
ALGOMA STEEL	-4.28	1.49	2.89	-0.09	6.14	1.23
AMERICAN BARRICK RESOURCES	-10.11	1.01	4.15	6.84	4.88	1.35
BELMORAL MINES	-31.40	13.06	-13.60	2.23	2.90	-5.36
CANAMAX RESOURCES	-4.01	-12.86	-11.01	-27.24	-25.75	-16.17
DENISON MINES	8.52	6.80	-9.07	1.45	5.29	2.60
DOFASCO	9.11	11.48	8.92	7.32	7.11	8.79
ELDORADO NUCLEAR	4.29	5.02	1.89	1.33	9.88	4.48
FALCONBRIDGE	3.43	7.99	6.33	4.41	5.77	5.59
GIANT YELLOWKNIFE	12.56	3.41	14.50	8.15	8.21	9.37
GOLDEN SHIELD	-181.64	-472.00	-14.48	-5.09	-13.42	-137.33
GRANGES EXPLORATION	N/A	3.69	3.10	1.22	1.16	1.83
INCO	-4.58	1.65	5.90	3.70	9.10	3.16
LAC MINERALS	13.58	10.39	1.82	4.80	7.02	7.52
MINNOVA	-0.16	0.59	0.02	3.10	1.80	1.07
MUSCOCHO EXPLORATIONS	-6.18	-10.07	-2.31	-4.98	-2.46	-5.20
NORANDA	3.21	4.35	3.43	4.35	6.51	4.37
PLACER DOME	6.55	4.01	5.41	6.28	8.68	6.19
RIO ALGOM	4.64	6.99	7.01	6.64	7.55	6.57
ST. ANDREW GOLDFIELDS	0.32	0.40	-0.16	-0.28	-0.79	-0.10
METAL MINING INDUSTRY	3.84	5.98	4.80	4.35	7.13	5.22

Source: Financial Post Information Service. Data manipulations based on costs estimates derived in the text. The operating monitoring costs have been adjusted for the marginal tax rate of 47%.

TABLE 3.4

Annual Capital Expenditures
($'000)

FIRM	1983	1984	1985	1986	1987	Average
Aginco Eagle Mines Ltd.	N/A	2,283	3,159	3,038	5,816	3,574
Algoma Steel Corp.	31,642	24,413	143,183	130,626	45,358	75,044
American Barrick Resources Corp.	N/A	19,140	17,411	27,796	134,585	49,733
Belmoral Mines Ltd.	6,236	8,250	1,112	8,768	16,115	8,096
Canamax Resources Inc.	24,930	565	11,253	15,808	35,111	17,533
Denison Mines Ltd.	N/A	111,798	196,016	193,918	49,472	137,801
Dofasco Inc.	52,686	83,879	171,702	423,213	415,584	229,413
Falconbridge Ltd.	24,321	52,683	43,476	106,658	85,702	62,568
Giant Yellowknife Mines Ltd.	N/A	2,888	2,244	2,829	88,122	24,021
Golden Shield Resources	N/A	222	1,589	7,103	44,173	13,272
Granges Exploration Ltd.	0	7,059	1,112	22,893	65,260	24,081
Inco Ltd.	N/A	103,578	93,229	138,538	137,942	118,322
Lac Minerals Ltd.	46,334	91,296	176,799	43,588	105,398	92,683
Minnova Inc.	11,057	31,860	10,654	26,483	60,261	28,063
Muscocho Explorations Ltd.	N/A	2,178	7,637	4,955	(12,728)	511
Noranda Inc.	N/A	433,073	315,948	229,615	473,017	362,913
Placer Dome Inc.	N/A	195,379	133,938	130,900	157,900	154,529
Rio Algom Ltd	166,000	42,498	110,080	108,108	70,446	99,426
St. Andrews Goldfields Ltd.	23,169	4,927	3,118	6,360	5,996	8,714
Hemlo Gold Mines Inc	N/A	N/A	N/A	N/A	N/A	N/A
Dickenson Mines Ltd.	N/A	N/A	N/A	N/A	N/A	N/A
Total	386,375	1,217,969	1,443,660	1,631,197	1,983,530	1,332,546

Source: Financial Post Information Service, 1988

TABLE 3.5

Incremental Monitoring Costs as a Percentage of Annual Capital Expenditures

FIRM	1983	1984	1985	1986	1987	Average
Aginco Eagle Mines Ltd.	N/A	20.59%	14.88%	15.47%	8.08%	13.15%
Algoma Steel Corp.	0.26%	0.34%	0.06%	0.06%	0.18%	0.11%
American Barrick Resources Corp.	N/A	0.55%	0.60%	0.38%	0.08%	0.21%
Belmoral Mines Ltd.	3.37%	2.55%	18.88%	2.40%	1.30%	2.59%
Canamax Resources Inc.	2.11%	92.92%	4.67%	3.32%	1.50%	2.99%
Denison Mines Ltd.	N/A	0.25%	0.14%	0.14%	0.57%	0.20%
Dofasco Inc.	0.21%	0.13%	0.06%	0.03%	0.03%	0.05%
Falconbridge Ltd.	2.57%	1.19%	1.44%	0.59%	0.73%	1.00%
Giant Yellowknife Mines Ltd	N/A	23.03%	29.63%	23.51%	0.75%	2.77%
Golden Shield Resources	N/A	47.30%	6.61%	1.48%	0.24%	0.79%
Granges Exploration Ltd.	N/A	1.49%	9.44%	0.46%	0.16%	0.44%
Inco Ltd.	N/A	0.59%	0.66%	0.44%	0.45%	0.52%
Lac Minerals Ltd.	0.23%	0.17%	0.09%	0.36%	0.15%	0.17%
Minnova Inc.	2.85%	0.33%	0.99%	0.40%	0.17%	0.37%
Muscocho Explorations Ltd.	N/A	14.46%	4.12%	6.36%	-2.47%	61.70%
Noranda Inc.	N/A	0.04%	0.05%	0.07%	0.03%	0.04%
Placer Dome Inc.	N/A	0.16%	0.24%	0.24%	0.20%	0.20%
Rio Algom Ltd	0.13%	0.85%	0.33%	0.33%	0.51%	0.36%
St. Andrews Goldfields Ltd.	N/A	4.26%	6.74%	3.30%	3.50%	2.41%
Hemlo Gold Mines Inc.	N/A	N/A	N/A	N/A	N/A	N/A
Dickenson Mines Limited	N/A	N/A	N/A	N/A	N/A	N/A
Total	1.43%	0.45%	0.38%	0.34%	0.28%	0.41%

Source: Financial Post Information Service, 1988; Mineral Group"A" Monitoring Regulation, Jan. 1988

The estimated monitoring capital costs as a percentage of annual capital expenditures are presented in Table 3.5. The highest monitoring capital cost estimates were used in this analysis. Capital costs for monitoring would account for between .3% and 1.5% of total capital investments for these 22 companies for the period 1983-87 with an average of .4%. Impacts are varied for the individual firms.

For 10 companies capital costs for monitoring account for less than 1% of annual capital expenditures during the period 1983-1987. The greatest impact of the monitoring capital costs would occur for Canamax in 1984 when capital monitoring costs would have represented 92% of the capital expenditure for that year. Capital expenditures for Canamax that year were extremely low; $565,000 down from $24,930,000 in 1983.

The very small impact which monitoring capital costs have on annual capital expenditures suggest that monitoring will not adversely alter the companies' capital investment plans.

The foregoing analyses reveal the impacts of the monitoring cost estimates for 21 companies which account for 67% of the mines that are subject to the MISA regulation.

Most of the other 29 mines for which financial data are not available are gold mining operations. Moreover, the financial data used for the 21 companies is generally consolidated information. The profitability of a firm's Ontario mining operations cannot always be determined from the consolidated financial accounts. Firms may be engaged in activities unrelated to the mining sector, or they may be producers of several different metals at different mines. They may operate in other provinces or countries. (ARA, 1988, p. 58). Only two companies of the 21 listed in Table 3.2 obtained profits exclusively from mining - related sales (ARA, 1988). Therefore, for some mines who operate as profit oriented subsidiaries of parent companies, the preceeding analyses may have underestimated the impacts of the costs of the monitoring regulations.

Finally, some mines are owned by joint ventures and holding companies so that it is very difficult to trace ownership of a particular mine location. Therefore, ultimate incidence of financial impacts cannot easily be determined and their significance is not readily apparent.

Based on available data, the two salt mining companies have been consistently profitable over the past 5-6 years and the estimated incremental monitoring costs do not appear to be a potential burden to these firms.

The monitoring regulations could have a positive impact on employment in Northern Ontario. The OMA estimated that each mine would require one additional employee full time to comply with the sampling requirements. If the mines fill this requirement externally, 84 jobs could be created for Northern Ontario for the 12-month period of the monitoring regulation. However, if some mines contract the services of a consultant in Southern Ontario for sampling then this figure would be somewhat lower.

The monitoring requirements will result in increased demand for laboratory services which could stimulate expansion for existing laboratory facilities in Thunder Bay. Flow measurement and sampling equipment companies could also face increased demand.

Employment figures and production data for mines where data were available is presented in Table 1 in Appendix "C". These data give an indication of the relative size of the different mine properties.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Total incremental capital and operating monitoring costs for the mineral industry Group "A" range from $19.0 to $32.0 million. Point estimates for individual mines are varied and range from $.22 to $.38 million.

Based on comparisons of the estimated monitoring costs of the proposed Regulation with potential costs of an "equitable" set of requirements, the proposed regulations which are plant and process specific appear to be cost-effective.

Costs of routine analyses for the current proposed process- specific regulations amount to as much as $3.2 million less than those analyses costs of the "equitable" scenario.

Throughout the early 1980's Canadian metal producers underwent significant restructuring, cost cutting and rationalization in response to lower metal prices caused by a decrease in demand and oversupply.

The mines subject to MISA regulation face differing outlooks according to the metal produced.

The financial impacts of the estimated monitoring costs on the Group "A" sector were analyzed using historical financial data for the period 1983-1987.

Capital costs for monitoring would account for between 1.5% and 0.3% of total capital investments for these 21 companies.

Operating costs of monitoring would decrease the return on capital employed only slightly for the majority of the 21 firms evaluated. These small changes would therefore save little effect on the long term profitability of the firms.

The financial analyses indicated that for the majority of the 21 companies the monitoring costs appear to be fiscally manageable.

Four companies, Canamax, Muscocho, Golden Shield Resources, and St. Andrew Goldfields, had losses in 1987 and in previous years. However, these companies are in the process of bringing mines into

production in the upcoming year. The favourable liquidity position of these companies together with earnings from gold operations expected in 1989 suggest that these companies will have the sufficient funds to meet additional environmental expenditures due to monitoring.

It does not appear that the monitoring costs will affect the international competitiveness of this industry in Ontario to any significant degree.

The monitoring requirements may also produce benefits to the mining companies. Companies may gain goodwill, and may be seen by the public as having an environmental conscience. This is particularly valuable in today's society which is becoming increasingly concerned with environmental problems. Internationally, firms may be seen as good corporate players and will exert pressure for other companies to become environmentally aware. Companies may also make gains in productivity by improving processes as a result of the monitoring regulations.

Lastly, there is a potential for plants to reduce raw material losses in wastewaters as a result of monitoring activities.

Compliance with the monitoring regulations will stimulate extra work at mines which is equivalent to 84 jobs in Northern Ontario and will result in increased demand for laboratory services and for flow measurement and sampling equipment. The monitoring database will be available to design cost-effective control programs aimed at eliminating toxic contamination where it occurs.

Lastly, the benefits of reducing pollution include enhanced recreation activities, better drinking water, better asethics and the knowledge that our society has taken a step towards preserving our water for generations to come.

4.2 Recommendations

In order to identify possible problems at an early stage, it is recommended that the MOE also monitor the actual incremental capital and operating costs of the monitoring activities during the tenure of the Regulations. Early identification of possible financial burdens will enable the MOE and the individual plant to review and assess workable solutions.

Also, at the end of the regulation period, each plant should report the actual incremental costs incurred in meeting MISA monitoring requirements in order to:

- validate and improve the cost-estimation procedures used in this report.

- monitor and assess the financial and employment impacts of the monitoring requirements.

- help to determine the full financial impact of the MISA requirements in both a domestic and international context when the costs of the limits regulations are determined.

Finally, when monitoring data and activities at these plants (and other industrial dischargers) are audited by the MOE personnel or their agents, information should be gathered to determine whether the monitoring activities or data have been, or could be, helpful in making the operations or processes production more efficient and productive.

APPENDIX 'A'

LIST OF MINES SUBJECT TO MISA MONITORING REGULATION

PLANT	SAMPLING POINT (Effluent)
Iron	
Algoma Steel Corp. Ltd. - Algoma Ore Division	Process
Dofasco Inc. - Adams Mine	Process
Dofasco Inc. - The Sherman Mine	Process
Total - 3 mines	
Silver	
Aginco-Eagle Mines Ltd. - Langis Mine	Minewater
Aginco-Eagle Mines Ltd. - Penn Mill	Process
Aginco-Eagle Mines Ltd. - Beaver-Timiskaming	Minewater
Aginco-Eagle Mines Ltd. - Leroy Project	Minewater EXP/DEV
Aginco-Eagle Mines Ltd. - Refinery	Smelter/Refinery
Aginco-Eagle Mines Ltd. - Silver Century Decline Project	Minewater EXP/DEV
Hellens - Eplett Mining Inc. - Colbalt	Process
Total - 7 mines: 2 EXP/DEV	
Uranium	
Denison Mines Ltd. - Stanrock Property	Stormwater
Denison Mines Ltd. - Elliot Lake	Process-Stormwater
Cameco - Blind River Refinery	Smelter/Refinery
Cameco - Port Hope Refinery	3-Smelter/Refinery
Rio Algom Ltd. - Quirke Mine	Process
Rio Algom Ltd. - Panel Mine	Process
Rio Algom Ltd. - Pronto Property	Stormwater
Rio Algom Ltd. - Lacnor Nordic	Stormwater
Rio Algom Ltd. - Stanleigh Mine	Process
Total - 9 mines	

APPENDIX 'A' (Continued)

LIST OF MINES SUBJECT TO MISA MONITORING REGULATION

PLANT	SAMPLING POINT (Effluent)
Copper, Nickel, Lead, Zinc	
Falconbridge Ltd. - Onaping Mine	Minewater
Falconbridge Ltd. - Strathcona (Moose Lake)	Process
Falconbridge Ltd. - Falconbridge Property	Process
Falconbridge Ltd. - Lockerby Property	Minewater
Inco Limited - Garson	Minewater
Inco Limited - Nickel Refinery	Smelter/Refinery
Inco Limited - Shebandowan Property	Process
Inco Limited - Copper Cliff Treatment Plant	Process
Inco Limited - Crean Hill	Minewater
Inco Limited - Levack	Minewater
Inco Limited - Nolin Creek Treatment Plant	Stormwater
Inco Limited - Refinery	Smelter/Refinery
Inco Limited - Whistle	Minewater
Kidd Creek Mines Ltd. - Metallurgical Site	Process
Kidd Creek Mines Ltd. - Kidd Creek Mine	Minewater
Mattabi Mines Ltd. - Sturgeon Lake	Process-Stormwater
Minnova Inc. - Winston Lake Mine	Process
Noranda Inc. - Lyon Lake Division	Minewater
Noranda Inc. - Geco Division	Process
Total - 19 mines	

APPENDIX 'A' (Continued)

LIST OF MINES SUBJECT TO MISA MONITORING REGULATION

PLANT	SAMPLING POINT (Effluent)
Gold	
American Barrick Resources Corp. - McDermott Property	Process
Ateba-Roxmark Joint Venture - Magnet Mine	Process EXP/DEV
Ateba Mines Ltd. - Beadmore	Process
Belmoral Mines Ltd. - Vedron Property	Minewater
Belmoral Mines Ltd. - Broulan Reef Product	Minewater
Canamax Resources Inc. - Clavas Project	Minewater
Canamax Resources Inc. - Marhill	Minewater
Canamax Resources Inc. - Bell Creek	Process
Canamax Resources Inc. - Kremzar Mine	Process
Canamax Resources Inc. - Matheson East Zone	Minewater
Citadel Gold Mines Inc. - McMurry Township	Minewater
Detour Lake Mines Ltd. - Detour Lake Mine	Process-Minewater
Dickenson Mines Ltd. - Arthur W. White Mine	Process
Diepdaume Mines Ltd. - Timmins	Process
Emerald Lake Resources - Golden Rose	Process
Getty Resources - Davidson-Tisdale	Minewater
Giant Yellowknife Mines Ltd. - ERG Resources	Process
Giant Yellowknife Mines Ltd. - Pamour #1	Process-Minewater
Giant Yellowknife Mines Ltd. - Pamour-Schumacher	Process-Minewater
Giant Yellowknife Mines Ltd. - Aunor-Delnite Property	Minewater
Giant Yellowknife Mines Ltd. - Ross Mine	Minewater
Golden Shield Resources - Kerr Division	Process
Granges Minerals - Mishibishu Lake Area	Minewater
Hemlo Gold Mines Inc. - Golden Giant Mine	Process
Kidd Creek Mines Ltd. - Owl Creek Mine	Minewater
Lac D'Aminante Du Quebec Ltée - Aquarius Mine	Process
Lac Minerals - Page Williams Mine	Process-Minewater
Lac Minerals - Macassa Division	Process

APPENDIX 'A' (Continued)

LIST OF MINES SUBJECT TO MISA MONITORING REGULATION

PLANT	SAMPLING POINT (Effluent)
Gold (Cont'd)	
Madeline Mines Ltd./Boise Minerals Inc. - Scramble Mine	Minewater EXP/DEV
Maude Lake Mine - Carr Township	Minewater
McFinley Red Lake Mines Ltd. - Bateman Township	Process
Muscocho Explorations Ltd. - Magnacon Mine	Minewater
Muscocho Explorations Ltd. - Majino Mine	Process-Minewater
Muscocho Explorations Ltd. - Jerome Mine	Minewater
Orofino Resources Inc. - Silk Township	Minewater
Orofino Resources Inc. - Scadding Mine	Process
Placer-Dome Inc. - Dona Lake Mine	Process
Placer-Dome Inc. - Dome Mine	Process
Placer-Dome Inc. - Campbell Red Lake Mine	Process
Placer-Dome Inc. - Opapamiskan Lake	Minewater EXP/DEV
Renabie Gold Mines Ltd. - Renabie	Process
Sandy K. Mines Ltd. - Gowganda	Process
St. Andrew Gold Fields - Taylor Township	Minewater
St. Andrew Gold Fields - Stock Township	Minewater
St. Joe Canada Ltd. - Muskegsagagen Lake	Process
Tanden Resources/Storimin Explorations - Moss Lake and Snodgrass Lake	Minewater
Teck Corona Operating Corporation - David Bell Mine	Process
Victoria Porcupine Resources - Naybob Property	Minewater
Wabigoon Development Inc. - Hunter Mine	Minewater
Total - 49 mines: 3 EXP/DEV	
Salt	
The Canadian Salt Company - Windsor	2 Process-Minewater
Domtar Chemicals Group - SIFTO Salt Division	Process-Minewater
Total - 2 mines	

Appendix "B" Incremental Operating and Capital Costs of Monitoring - In- House Sampling
Table 1

SCENARIO - IN HOUSE SAMPLING

Gold Subsector	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	TOTAL Low	TOTAL High
American Barrick Resources - McDermott Property	161,585	162,585	50,200	101,200	211,785	263,785
Ateba-Roxmark EXP/DEV	0	0	0	0	0	0
Ateba Mines Ltd.- Beardmore	161,277	162,277	51,200	101,200	212,477	263,477
Belmoral Mines - Vendron Property	161,277	162,277	51,200	101,200	212,477	263,477
Belmoral Mines Broulan Reef	161,277	162,277	51,200	101,200	212,477	263,477
Canamax Clavas Project	161,277	162,277	51,200	101,200	212,477	263,477
Canamax Marhill	161,277	162,277	51,200	101,200	212,477	263,477
Canamax Bell Creek	147,885	148,885	50,200	101,200	198,085	250,085
Canamax Krezmar Mine	161,585	162,585	50,200	101,200	211,785	263,785
Canamax Matheson East Zone	147,577	148,577	50,200	101,200	197,777	249,777
Citadel Gold Mines Inc. - McMurry Twp.	161,277	162,277	51,200	101,200	212,477	263,477
Detour Lake Mines Ltd. - Detour Lake Mine	234,311	236,311	79,200	171,200	313,511	407,511
Dickenson Mines Ltd - Arthur W. White Mine	161,585	162,585	36,200	46,200	197,785	208,785
Diepdaume Mines Ltd. - Timmins	161,585	162,585	50,200	101,200	211,785	263,785
Emerald Lake Resources - Golden Rose	147,885	148,885	50,200	101,200	198,085	250,085
Getty Resources - Davison-Tisdale	147,577	148,577	50,200	101,200	197,777	249,777
Giant Yellowknife Mines Ltd - ERG Resources	161,585	162,585	55,200	101,200	216,785	263,785
Giant Yellowknife Mines Ltd. - Pamour 1	234,311	236,311	70,200	171,200	304,511	407,511
Giant Yellowknife Mines Ltd.- Pamour-Schumacher	234,311	236,311	54,700	171,200	289,011	407,511
Giant Yellowknife Mines Ltd.- Aunor- Delnite	147,577	148,577	50,200	101,200	197,777	249,777
Giant Yellowknife Mines Ltd - Ross Mine	161,277	162,277	50,200	101,200	211,477	263,477
Golden Shield Resources - Kerr Division	161,585	162,585	50,200	101,200	211,785	263,785
Granges Minerals - Mishibishu Lake Area	161,277	162,277	50,200	101,200	211,477	263,477
Hemlo Gold Mines Inc. - Golden Giant Mine	161,585	162,585	50,200	101,200	211,785	263,785
Kidd Creek Mines Ltd. - Owl Creek Mine	147,577	148,577	50,200	101,200	197,777	249,777
Lac D'Aminate Du Quebec Ltee - Aquarious Mine	161,585	162,585	51,200	101,200	212,785	263,785
Lac Minerals - Page Williams	165,805	167,805	69,200	101,200	235,005	269,005
Lac Minerals - Macassa Division	161,585	162,585	36,200	46,200	197,785	208,785
Madeline Mines Ltd./ Boise Minerals Inc. EXP/DEV	0	0	0	0	0	0
Maude Lake Mine - Carr Twp	161,277	162,277	51,200	101,200	212,477	263,477
McFinley Red Lake Mines Ltd. -Bateman Twp.	161,585	162,585	51,200	101,200	212,785	263,785
Muscocho Explorations Ltd.- Magnacon Mine	161,277	162,277	50,200	101,200	211,477	263,477
Muscocho Explorations Ltd.- Majino	220,611	222,611	68,200	101,200	288,811	323,811
Muscocho Explorations Ltd.- Jerome Mine	161,277	162,277	51,200	101,200	212,477	263,477
Orofina Resources Inc. -Silk Twp.	161,277	162,277	51,200	101,200	212,477	263,477
Orofina Resources Inc. -Scadding Mine	147,577	148,577	50,200	101,200	197,777	249,777
Placer-Dome Inc. - Dona lake	161,585	162,585	50,200	101,200	211,785	263,785
Placer - Dome -Dome Mine	230,091	231,091	55,200	101,200	285,291	332,291
Placer - Dome -Campbell Red Lake Mine	161,585	162,585	50,200	101,200	211,785	263,785
Placer - Dome - Opapamiskan Lake EXP/DEV	0	0	0	0	0	0
Renabie Gold Mines Ltd. - Renabie	161,585	162,585	50,200	101,200	211,785	263,785
Sandy K. Mines Ltd. - Gowaganda	161,585	162,585	51,200	101,200	212,785	263,785
St. Andrew Goldfields- Taylor Twp.	161,277	162,277	51,200	101,200	212,477	263,477
St. Andrew Goldfields- Stock Twp	161,277	162,277	51,200	101,200	212,477	263,477
St. Joe Canada Ltd -Muskegsagagen Lake	161,585	162,585	51,200	101,200	212,785	263,785
Tanden Resources / Storimin Exp.- Moss and Snograss	161,585	162,585	51,200	101,200	212,785	263,785
Tech Corona Operating Corp. - David Bell Mine	161,585	162,585	50,200	101,200	211,785	263,785
Victoria Porcupine Resources - Naybob Property	161,277	162,277	51,200	101,200	212,477	263,477
Wabigoon Development Inc. - Hunter Mine	161,277	162,277	51,200	101,200	212,477	263,477
Total	$7,680,472	$7,731,472	$2,399,700	$4,755,200	$10,080,172	$12,486,672

Appendix "B" Incremental Operating and Capital Costs of Monitoring - In- House Sampling

Scenario - In House Sampling

Subsector Iron	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	TOTAL Low	TOTAL High
Algoma Steel Corp. Ltd - Algoma Ore Division	133,502	138,836	51,200	101,200	184,702	240,036
Dofasco Inc.-Adams Mine	133,502	138,836	50,200	101,200	183,702	240,036
Dofasco Inc.- Sherman Mine	133,502	138,836	36,200	46,200	169,702	185,036
					0	0
Total	$400,506	$416,508	$137,600	$248,600	$538,106	$665,108

Scenario - In House Sampling

Subsector Silver	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	TOTAL Low	TOTAL High
Aginco-Eagle Miner Ltd - Langis Mine	109,253	113,651	50,200	101,200	159,453	214,851
Aginco-Eagle Mines Ltd. - Penn Mill	109,253	113,651	50,200	101,200	159,453	214,851
Aginco-Eagle Mines Ltd. - Beaver-Timiskaming	109,253	113,651	50,200	101,200	159,453	214,851
Aginco-Eagle Mines Ltd-Refinery	140,340	144,738	46,200	101,200	186,540	245,938
Aginco-Eagle -Leroy EXP/DEV	0	0	0	0	0	0
Aginco-Eagle -Silver Decline EXP/DEV	0	0	0	0	0	0
Hellens - Eplett Mining Inc - Cobalt	109,253	113,651	50,200	101,200	159,453	214,851
TOTAL	$577,352	$599,342	$247,000	$506,000	$824,352	$1,105,342

Scenario - In House Sampling

Subsector Uranium	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	TOTAL Low	TOTAL High
Denison Mines Ltd.- Stanrock Property	110,824	115,216	50,200	101,200	161,024	216,416
Denison Mines Ltd.- Elliot Lake	159,255	164,647	77,200	171,200	236,455	335,847
Cameco - Blind River Refinery	118,669	123,061	50,200	101,200	168,869	224,261
Cameco - Port Hope Refinery	215,407	221,799	87,200	241,200	302,607	462,999
Rio Algom Ltd.- Quirke Mine	132,431	136,823	36,200	46,200	168,631	183,023
Rio Algom Ltd.- Panel Mine	132,431	136,823	36,200	46,200	168,631	183,023
Rio Algom Ltd.- Pronto Property	110,824	115,216	50,200	101,200	161,024	216,416
Rio Algom Ltd. - Lacnor Nordic	110,824	115,216	50,200	101,200	161,024	216,416
Rio Algom Ltd. - Stanleigh Mine	132,431	136,823	36,200	46,200	168,631	183,023
TOTAL	$1,223,096	$1,265,624	$473,800	$955,800	$1,696,896	$2,221,424

Appendix "B" Incremental Operating and Capital Costs of Monitoring - In- House Sampling

Scenario - In House Sampling

Subsector Salt	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	TOTAL Low	TOTAL High
The Canadian Salt Company - Windsor	173,195	180,679	60,200	241,200	233,395	421,879
Domtar Chemicals Group - SIFTO Salt Division	143,367	149,851	69,200	171,200	212,567	321,051
					0	0
Total	$316,562	$330,530	$129,400	$412,400	$445,962	$742,930

Scenario - In House Sampling

Subsector Copper, Nicke`, Lead, Zinc	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	TOTAL Low	TOTAL High
Falconbridge Ltd- Onaping Mine	152,818	158,151	36,200	46,200	189,018	204,351
Falconbridge Ltd- Strathcona	153,100	158,433	51,200	101,200	204,300	259,633
Falconbridge Ltd.- Falconbridge Property	153,100	158,433	50,200	101,200	203,300	259,633
Falconbridge Ltd.- Lockerby Property	152,818	158,151	50,200	101,200	203,018	259,351
Inco Ltd - Carson	152,818	158,151	51,200	101,200	204,018	259,351
Inco Ltd. - Nickel Refinery	148,622	153,955	51,200	101,200	199,822	255,155
Inco Ltd. - Shebandowan Property	153,100	158,433	50,200	101,200	203,300	259,633
Inco Ltd - Copper Cliff Treatment Plant	153,100	158,433	36,200	46,200	189,300	204,633
Inco Ltd. - Crean Hill	152,818	158,151	36,200	46,200	189,018	204,351
Inco Ltd. - Levack	152,818	158,151	36,200	46,200	189,018	204,351
Inco Ltd. - Nolin Creek Treatment Plant	108,892	114,225	36,200	46,200	145,092	160,425
Inco Ltd. - Refinery	148,622	153,955	36,200	46,200	184,822	200,155
Inco Ltd. - Whistle	152,818	158,151	36,200	46,200	189,018	204,351
Kidd Creek Mines Ltd. - Metalurgical Site	153,100	158,433	51,200	101,200	204,300	259,633
Kidd Creek Mines Ltd.- Kidd Creek Mine	152,818	158,151	36,200	46,200	189,018	204,351
Mattabi Mines Ltd - Sturgeon Lake	177,692	183,025	41,200	46,200	218,892	229,225
Minnova Inc. - Winston Lake Mine	153,100	158,433	50,200	101,200	203,300	259,633
Noranda Inc.- Lyon Lake Division	152,818	158,151	50,200	101,200	203,018	259,351
Noranda Inc.- Geco Division	153,100	158,433	36,200	46,200	189,300	204,633
TOTAL	$2,878,072	$2,979,399	$822,800	$1,372,800	$3,700,872	$4,352,199

Appendix "B" Incremental Operating and Capital Costs of Monitoring - Consultant Sampling

Table 2

SCENARIO - CONSULTANT SAMPLING

Gold Subsector	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
American Barrick Resources - McDermott Property	271,805	272,805	54,000	105,000	325,805	377,805
Ateba-Roxmark EXP/DEV	0	0	0	0	0	0
Ateba Mines Ltd.- Beardmore	271,497	272,497	55,000	105,000	326,497	377,497
Belmoral Mines - Vendron Property	271,497	272,497	55,000	105,000	326,497	377,497
Belmoral Mines Broulan Reef	271,497	272,497	55,000	105,000	326,497	377,497
Canamax Clavas Project	271,497	272,497	55,000	105,000	326,497	377,497
Canamax Marhill	271,497	272,497	55,000	105,000	326,497	377,497
Canamax Bell Creek	258,105	259,105	54,000	105,000	312,105	364,105
Canamax Krezmar Mine	271,805	272,805	54,000	105,000	325,805	377,805
Canamax Matheson East Zone	257,797	258,797	54,000	105,000	311,797	363,797
Citadel Gold Mines Inc. - McMurry Twp.	271,497	272,497	55,000	105,000	326,497	377,497
Detour Lake Mines Ltd. - Detour Lake Mine	343,011	345,011	83,000	175,000	426,011	520,011
Dickenson Mines Ltd - Arthur W. White Mine	271,805	272,805	40,000	50,000	311,805	322,805
Diepdaume Mines Ltd. - Timmins	271,805	272,805	54,000	105,000	325,805	377,805
Emerald Lake Resources - Golden Rose	258,105	259,105	54,000	105,000	312,105	364,105
Getty Resources - Davison-Tisdale	257,797	258,797	54,000	105,000	311,797	363,797
Giant Yellowknife Mines Ltd - ERG Resources	271,805	272,805	59,000	105,000	330,805	377,805
Giant Yellowknife Mines Ltd. - Pamour 1	343,011	345,011	74,000	175,000	417,011	520,011
Giant Yellowknife Mines Ltd.- Pamour-Schumacher	343,011	345,011	58,500	175,000	401,511	520,011
Giant Yellowknife Mines Ltd.- Aunor- Delnite	257,797	258,797	54,000	105,000	311,797	363,797
Giant Yellowknife Mines Ltd - Ross Mine	271,497	272,497	54,000	105,000	325,497	377,497
Golden Shield Resources - Kerr Division	271,805	272,805	54,000	105,000	325,805	377,805
Granges Minerals - Mishibishu Lake Area	271,497	272,497	54,000	105,000	325,497	377,497
Hemlo Gold Mines Inc. - Golden Giant Mine	271,805	272,805	54,000	105,000	325,805	377,805
Kidd Creek Mines Ltd. - Owl Creek Mine	257,797	258,797	54,000	105,000	311,797	363,797
Lac D'Aminate Du Quebec Ltee - Aquarious Mine	271,805	272,805	55,000	105,000	326,805	377,805
Lac Minerals - Page Williams	274,505	276,505	73,000	105,000	347,505	381,505
Lac Minerals - Macassa Division	271,805	272,805	40,000	50,000	311,805	322,805
Madeline Mines Ltd./ Boise Minerals Inc. EXP/DEV	0	0	0	0	0	0
Maude Lake Mine - Carr Twp	271,497	272,497	55,000	105,000	326,497	377,497
McFinley Red Lake Mines Ltd. -Bateman Twp.	271,805	272,805	55,000	105,000	326,805	377,805
Muscocho Explorations Ltd.- Magnacon Mine	271,497	272,497	54,000	105,000	325,497	377,497
Muscocho Explorations Ltd.- Majino	329,311	331,311	72,000	105,000	401,311	436,311
Muscocho Explorations Ltd.- Jerome Mine	271,497	272,497	55,000	105,000	326,497	377,497
Orofina Resources Inc. -Silk Twp.	271,497	272,497	55,000	105,000	326,497	377,497
Orofina Resources Inc. -Scadding Mine	257,797	258,797	54,000	105,000	311,797	363,797
Placer-Dome Inc. - Dona lake	271,805	272,805	54,000	105,000	325,805	377,805
Placer - Dome -Dome Mine	340,311	341,311	59,000	105,000	399,311	446,311
Placer - Dome -Campbell Red Lake Mine	271,805	272,805	54,000	105,000	325,805	377,805
Placer - Dome - Opapamiskan Lake EXP/DEV	0	0	0	0	0	0
Renabie Gold Mines Ltd. - Renabie	271,805	272,805	54,000	105,000	325,805	377,805
Sandy K. Mines Ltd. - Gowaganda	271,805	272,805	55,000	105,000	326,805	377,805
St. Andrew Goldfields- Taylor Twp.	271,497	272,497	55,000	105,000	326,497	377,497
St. Andrew Goldfields- Stock Twp	271,497	272,497	55,000	105,000	326,497	377,497
St. Joe Canada Ltd -Muskegsagagen Lake	271,805	272,805	55,000	105,000	326,805	377,805
Tanden Resources / Storimin Exp.- Moss and Snograss	271,805	272,805	55,000	105,000	326,805	377,805
Tech Corona Operating Corp. - David Bell Mine	271,805	272,805	54,000	105,000	325,805	377,805
Victoria Porcupine Resources - Naybob Property	271,497	272,497	55,000	105,000	326,497	377,497
Wabigoon Development Inc. - Hunter Mine	271,497	272,497	55,000	105,000	326,497	377,497
Total	$12,742,992	$12,793,992	$2,574,500	$4,930,000	$15,317,492	$17,723,992

Incremental Operating and Capital Costs of Monitoring - Consultant Sampling

Scenario - Consultant Sampling

Subsector Iron	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Algoma Steel Corp. Ltd - Algoma Ore Division	239,723	240,723	55,000	105,000	294,723	345,723
Dofasco Inc.-Adams Mine	239,723	240,723	54,000	105,000	293,723	345,723
Dofasco Inc.- Sherman Mine	239,723	240,723	40,000	50,000	279,723	290,723
Total	$719,169	$722,169	$149,000	$260,000	$868,169	$982,169

Scenario - Consultant Sampling

Subsector Silver	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Aginco-Eagle Miner Ltd - Langis Mine	212,835	213,835	54,000	105,000	266,835	318,835
Aginco-Eagle Mines Ltd. - Penn Mill	212,835	213,835	54,000	105,000	266,835	318,835
Aginco-Eagle Mines Ltd. - Beaver-Timiskaming	212,835	213,835	54,000	105,000	266,835	318,835
Aginco-Eagle Mines Ltd-Refinery	243,922	244,922	50,000	105,000	293,922	349,922
Aginco-Eagle -Leroy EXP/DEV	0	0	0	0	0	0
Aginco-Eagle -Silver Decline EXP/DEV	0	0	0	0	0	0
Hellens - Eplett Mining Inc - Cobalt	212,835	213,835	54,000	105,000	266,835	318,835
TOTAL	$1,095,262	$1,100,262	$266,000	$525,000	$1,361,262	$1,625,262

Scenario - Consultant Sampling

Subsector Uranium	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Denison Mines Ltd.- Stanrock Property	215,636	216,636	54,000	105,000	269,636	321,636
Denison Mines Ltd.- Elliot Lake	262,547	264,547	81,000	175,000	343,547	439,547
Cameco - Blind River Refinery	223,481	224,481	54,000	105,000	277,481	329,481
Cameco - Port Hope Refinery	317,179	320,179	91,000	245,000	408,179	565,179
Rio Algom Ltd.- Quirke Mine	237,243	238,243	40,000	50,000	277,243	288,243
Rio Algom Ltd.- Panel Mine	237,243	238,243	40,000	50,000	277,243	288,243
Rio Algom Ltd.- Pronto Property	215,636	216,636	54,000	105,000	269,636	321,636
Rio Algom Ltd. - Lacnor Nordic	215,636	216,636	54,000	105,000	269,636	321,636
Rio Algom Ltd. - Stanleigh Mine	237,243	238,243	40,000	50,000	277,243	288,243
TOTAL	$2,161,844	$2,173,844	$508,000	$990,000	$2,669,844	$3,163,844

Incremental Operating and Capital Costs of Monitoring - Consultant Sampling

Scenario - Consultant Sampling

Subsector Salt	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
The Canadian Salt Company - Windsor	270,819	273,819	64,000	245,000	334,819	518,819
Domtar Chemicals Group - SIFTO Salt Division	242,511	244,511	73,000	175,000	315,511	419,511
					0	0
Total	$513,330	$518,330	$137,000	$420,000	$650,330	$938,330

Scenario - Consultant Sampling

Subsector Copper, Nickel, Lead, Zinc	Operating Costs Low	Operating Costs High	Capital Costs Low	Capital Costs High	Total Low	Total High
Falconbridge Ltd- Onaping Mine	267,371	268,371	40,000	50,000	307,371	318,371
Falconbridge Ltd- Strathcona	267,653	268,653	55,000	105,000	322,653	373,653
Falconbridge Ltd.- Falconbridge Property	267,653	268,653	54,000	105,000	321,653	373,653
Falconbridge Ltd.- Lockerby Property	267,371	268,371	54,000	105,000	321,371	373,371
Inco Ltd - Carson	267,371	268,371	55,000	105,000	322,371	373,371
Inco Ltd. - Nickel Refinery	263,175	264,175	55,000	105,000	318,175	369,175
Inco Ltd. - Shebandowan Property	267,653	268,653	54,000	105,000	321,653	373,653
Inco Ltd - Copper Cliff Treatment Plant	267,653	268,653	40,000	50,000	307,653	318,653
Inco Ltd. - Crean Hill	267,371	268,371	40,000	50,000	307,371	318,371
Inco Ltd. - Levack	267,371	268,371	40,000	50,000	307,371	318,371
Inco Ltd. - Nolin Creek Treatment Plant	223,445	224,445	40,000	50,000	263,445	274,445
Inco Ltd. - Refinery	263,175	264,175	40,000	50,000	303,175	314,175
Inco Ltd. - Whistle	267,371	268,371	40,000	50,000	307,371	318,371
Kidd Creek Mines Ltd. - Metalurgical Site	267,653	268,653	55,000	105,000	322,653	373,653
Kidd Creek Mines Ltd.- Kidd Creek Mine	267,371	268,371	40,000	50,000	307,371	318,371
Mattabi Mines Ltd - Sturgeon Lake	290,725	291,725	45,000	50,000	335,725	341,725
Minnova Inc. - Winston Lake Mine	267,653	268,653	54,000	105,000	321,653	373,653
Noranda Inc.- Lyon Lake Division	267,371	268,371	54,000	105,000	321,371	373,371
Noranda Inc.- Geco Division	267,653	268,653	40,000	50,000	307,653	318,653
					0	0
TOTAL	$5,053,059	$5,072,059	$895,000	$1,445,000	$5,948,059	$6,517,059

APPENDIX "C"

Table 1
EMPLOYMENT AND CAPACITY OF INDIVIDUAL MINES IN ONTARIO

MINES Gold Subsector	NO. OF EMPLOYEES (1987)	CAPACITY TONS\DAY (1987) **
American Barrick Resources	155	1,500
Ateba-Roxmark EXP/DEV	28	200
Belmoral Mines - Vedron)		
Belmoral Mines LTD)	330	2,000
Canamax Bell Creek *	93	385
Canamax Krezmar *	53	500
Canamax Matheson	-	275
Citadel Gold Mines LTD *	91	500
Consolidated Professor	-	450
Detour Lake *	306	2,200
Dickenson Mines Ltd. *	381	700
Diepdaume	-	600
Emerald Lake (Noramco)	80	400
Getty Resources		200
Giant Yellowknife- Pamour 1	347	2,800
Giant Yellowknife- Schumacher	305	2,700
Giant Yellowknife- Timmins	15	400
Giant Yellowknife- Ross Mine	81	750
Golden Shield- Kerr Mine *	376	1,350
Granges Exploration	68	500
Hemlo Gold *	279	3,000
Owl Creek (Div. of Kidd Creek)	15	500
Lac D'Aminate	-	-
Lac - Page Williams *	518	3,000
Lac - Macassa *	310	500
Madelaine Mines	-	3,000
Maude Lake	-	-
McFinley	-	
Muscocho - Magnacon Project	-	600
Muscocho- Majino	-	400
Muscocho- Jerome	-	-
Nuinsco	-	-
Orofina -Silk	-	-
Orofina -Scadding	18	200
Placer - Dome -Dona lake	2,600	550
Placer - Dome -Dome Mine *	757	3,000
Placer - Dome -Campbell	2,075	1,200
Renabie *	182	700
St. Andrew Goldfields- Taylor *	20	500
St. Andrew Goldfields- Stock	-	500
St. Joe- Golden Mine	-	250
Tanden	-	-
Tech Corona *	200	1,000
Victoria Porcupine	-	-
Wabigoon	-	-
Total:	9,683	37,310

APPENDIX "C"

Table 1
EMPLOYMENT AND CAPACITY OF INDIVIDUAL MINES IN ONTARIO

MINES	NO. OF EMPLOYEES (1987)	CAPACITY TONS\DAY (1987) **
Iron Subsector		
Algoma *	334	3,750
Dofasco-Adams Mine *	333	3,500
Dofasco - The Sherman Mine *	351	2,700
Total:	1,018	9,950
Silver Subsector		
Aginco-Eagle -Langis	-	400
Aginco-Eagle -Penn	-	-
Aginco-Eagle -Beaver	-	-
Aginco-Eagle -Refinery	-	200
Aginco-Eagle -Lery EXP/DEV	125	300
Aginco-Eagle - Decline EXP/DEV	-	-
Hellens - Eplett	31	80
TOTAL:	156	980
Uranium Subsector		
Denison- Stanrock }	-	-
Denison - Elliot Lake }*	1,953	15,000
Cameco - Blind River Refinery	-	-
Cameco - Port Hope	-	-
Eldorado Resources	-	-
Rio Algom -Quirke Mine *	1,169	7,000
Rio Algom - Panel *	664	3,300
Rio Algom -Pronto	-	-
Rio Algom -Lacnor	-	-
Rio Algom -Stanleigh *	535	5,000
TOTAL:	4,321	30,300

APPENDIX "C"

Table 1
EMPLOYMENT AND CAPACITY OF INDIVIDUAL MINES IN ONTARIO

Salt Subsector	NO. OF EMPLOYEES (1987)	CAPACITY TONS\DAY (1987) **
Canadian Salt Company *	254	450
Domtar *	321	9,600
Total:	572	10,050

Copper, Nickel, Lead Subsector		
Falconbridge - Onaping	-	-
Falconbridge - Strathcona	-	10,000
Falconbridge - Falconbridge	2,315	2,700
Falconbridge - Lockerby	-	8,100
Inco-Carson)		4,000
Inco-Nickel)		18,000
Inco-Shebandowan)		3,900
Inco-Copper Cliff)		5,400
Inco-Crean)	8,348	3,000
Inco-Levack)		7,000
Inco-Nolin)		-
Inco-Refinery)		-
Inco-Whistle)		-
Kidd Creek - Metalurgical Site *	1,383	-
Kidd Creek - Kidd Creek *	990	12,000
Mattabi Mines) *		3,000
Noranda - Lyon Lake)	288	1,100
Noranda - Geco *	491	5,000
Minnova- Winston Lake *	121	1,000
TOTAL:	14,962	103,300
SECTOR TOTAL: #	27,785	162,840

Does not reflect actual total for Ontario since data is not available for some of the mines.

Source: Canadian Mines Handbook, 1988-89
* Mines Accident Prevention Association Ontario Injury Statistics, Jan - Nov 1988
** Canadian Mines Handbook, 1988-89, and from figures obtained from the Ontario Mining Association

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